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SimNavy Phase 1

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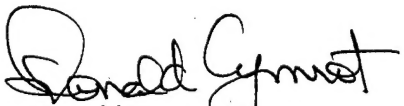

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This paper summarizes phase I development of an agent-based interactive game called SimNavy. The purpose of the game is to teach users through simulated experience how best to manage the Navy's resources in order to reach operational objectives. This paper provides a description of the SimNavy concept and the role CNA could play in its future development.

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SimNavy
Phase 1

Linda Cavalluzzo

Overview

- The Concept
- The Technology
- CNA Contribution to Phase 1
  - Resource-to-Readiness Relationships
- IWARS: A Complex Adaptive System
- Applications of Agent-Based Technology
- Long-Term Role for CNA

This paper summarizes phase 1 development of an agent-based interactive game called SimNavy. The purpose of the game is to teach users through simulated experience how best to manage the Navy's resources in order to reach operational objectives.

Background

- Linking entertainment and defense
  - Naval Postgraduate School
  - Thinking Tools
  - Center for Naval Analyses
- Phase 1 funded by ONR and presented at the Technology Initiatives Games, Oct '98

In the summer of 1998, the Office of Naval Research, with backing from N7, provided seed money to begin conceptual development of an interactive simulation model of the workings of the U.S. Navy enterprise.

Professor Mike Zyda, chair of the Modeling, Virtual Environments and Simulation (MOVES) Academic Group at the Naval Postgraduate School, led the effort, bringing in John Hiles, then CEO of Thinking Tools Corporation, a commercial company that specializes in computer games as learning tools for the business community, and CNA, whose broad-based expertise would help guide the development of the underlying rules and relationships that are central to the simulator's solutions.

A mock-up of SimNavy was assembled and presented to attendees of the Technology Initiatives Games (TIG) in October 1998. This paper provides a description of the SimNavy concept and the role that CNA could play in its future development. The slides used in the presentation to the TIG can be obtained by request at cavallu@cna.org.

The Concept

- Computer-based game
- Using "agent-based adaptive simulation" technology to reach solutions
- Simulates OPNAV/N-code operation
- Exposes the interdependencies among distant Navy components and the contribution of components to operational capability

The inspiration for SimNavy comes from the 1997 National Research Council study, "Modeling and Simulation: Linking Entertainment and Defense," which argues that the military would benefit from collaboration between its M&S community and the corresponding community in the entertainment industry [1].

Although the military has sophisticated computer-based analytic tools, those tools usually lack the highly developed software interfaces that have been the mainstay of the entertainment industry, which has channeled its efforts to the design of exciting, realistic, and absorbing games for use by the general public.

Unlike military simulation models that have come before it, SimNavy is envisioned to be a deeply engaging, computer-based game, with a high-quality graphical interface. The game would take little effort to begin to play and would employ a new technology—"agent-based adaptive simulation"—to reach solutions.

SimNavy is designed to simulate OPNAV/N-code operations of the Navy, with consequences on the capability of operational forces to accomplish their assigned missions. Players would, through their experiences, come away with a newfound understanding of the interdependencies among distant components of the Navy enterprise and the contribution of these components to operational capability.

Game Layout

- Event editor
- Assumption editor
- Budget allocations
- Global mission display
- Operational control

SimNavy is expected to be organized into five basic parts. The event editor would generate the events to which the player will respond throughout play—such events as training exercises, force projection, humanitarian operations, and conflicts. These events could be selected by the player or randomly generated by the simulator.

The assumption editor allows the player to select the event-generation process—benign, realistic, or malevolent—which will affect the level of difficulty of play. The assumption editor is also home to the designer's assumptions about relationships between key variables. These assumptions will be accessible, linked to references, and capable of being changed.

In the budget allocation window, the player would allocate spending across an array of categories. When assigning resources to different categories, the player may choose to make allocations at various levels of detail. For example, choose a funding level for the manpower and personnel (MPN) account overall, or go to a drop-down menu that allows for making allocations within MPN, to programs such as recruiting, selective reenlistment bonuses, or training. Once the budget is allocated, the game can begin.

Events occur in the global mission display. This display would show the status of events and would have clickable icons for additional levels of information. The player has operating control, that is, the ability to assign forces to deal with events. Resource levels decline as forces conduct operations. Misallocated resources can make the difference between mission success and failure.

The Technology

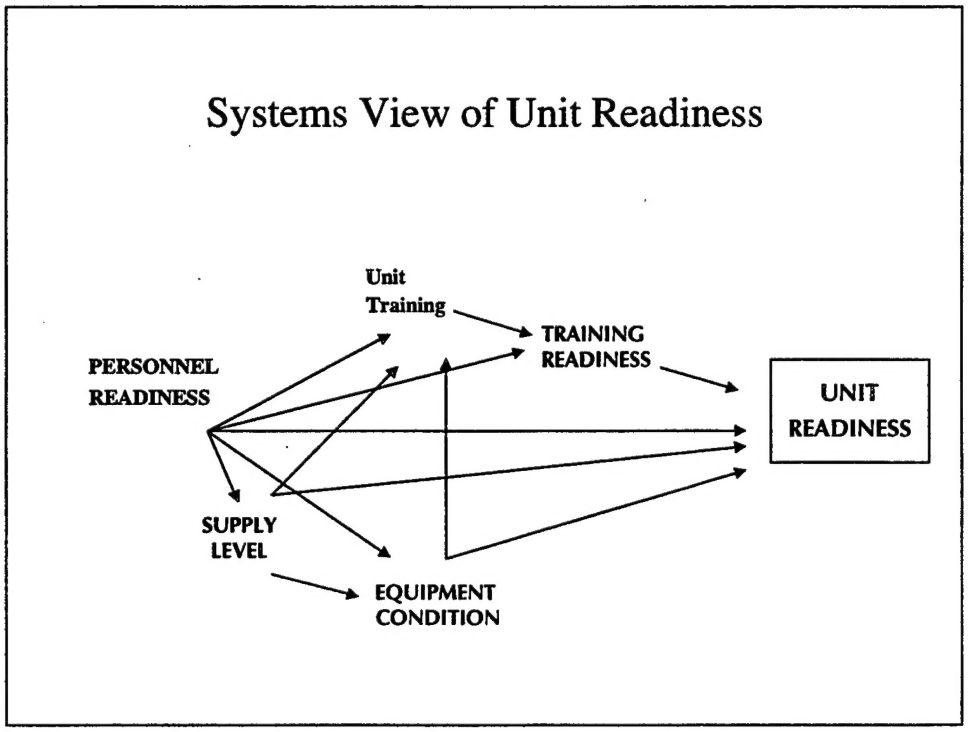
- Agent-based adaptive simulation
  - Bottom-up game design
  - Many agents, following their own scripted function or behavioral rules
  - Agents interact and respond according to the scripted rules
  - Viewed in the aggregate, clear patterns develop, "emergent behavior"

Agent-based adaptive simulation is one of several names given to an analytic technique that uses simple rules or mathematical functions to describe the behavior of individual agents. In the world of SimNavy, an agent might be Naval Recruiting Command, and one rule might be to increase advertising when recruiting rates fall below the desired level. So the command is a semiautonomous agent, with behavior that adapts to meet its goal.

SimNavy would have thousands of such agents, each responding to changes in the agent's local environment, with changes in the local environment coming about from the behavior of other semiautonomous agents as new events unfold.

From the simple interactions among numerous agents, the player will find that, when the system is viewed as a whole, behavioral patterns emerge. These patterns are called emergent behavior. It is this behavior that leads to the lessons learned through the modeling technique.

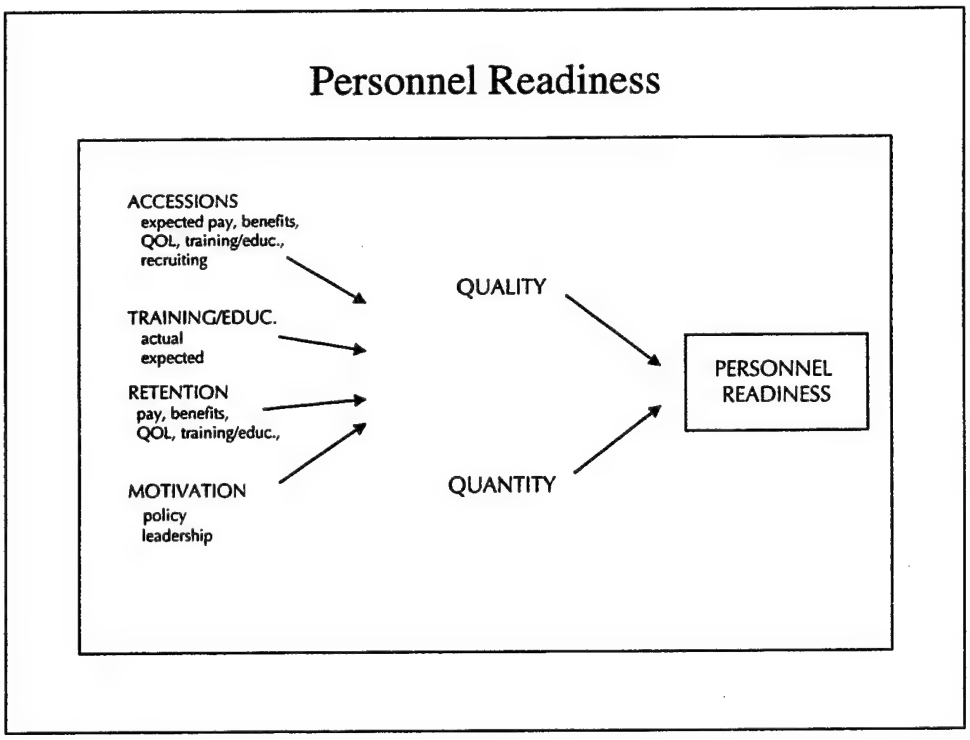
To continue with our example above, the player may have underresourced the recruiting command at the start. In the face of unmet goals, money might be diverted from other MPN accounts to support additional advertising. Sailors (also semiautonomous agents) observe a decline in their quality of life and respond by leaving the service. Experience levels drop in operational units. Readiness suffers.



Although agent-based adaptive simulation reaches solutions without the need for a large integrated mathematical model, the designers must be able to identify key agents and model their behavior correctly. In addition, an understanding of system interrelationships can guide the choice of events to ensure that important lessons evolve from game play.

The SimNavy team worked with the systems view of unit readiness during development of the game mock-up [2]. This figure provides an overview of the complicated interrelationships that exist among resource areas and unit readiness.

The next slides show the systems view in greater detail. Because personnel readiness has both direct and indirect influences throughout the system, we begin there.

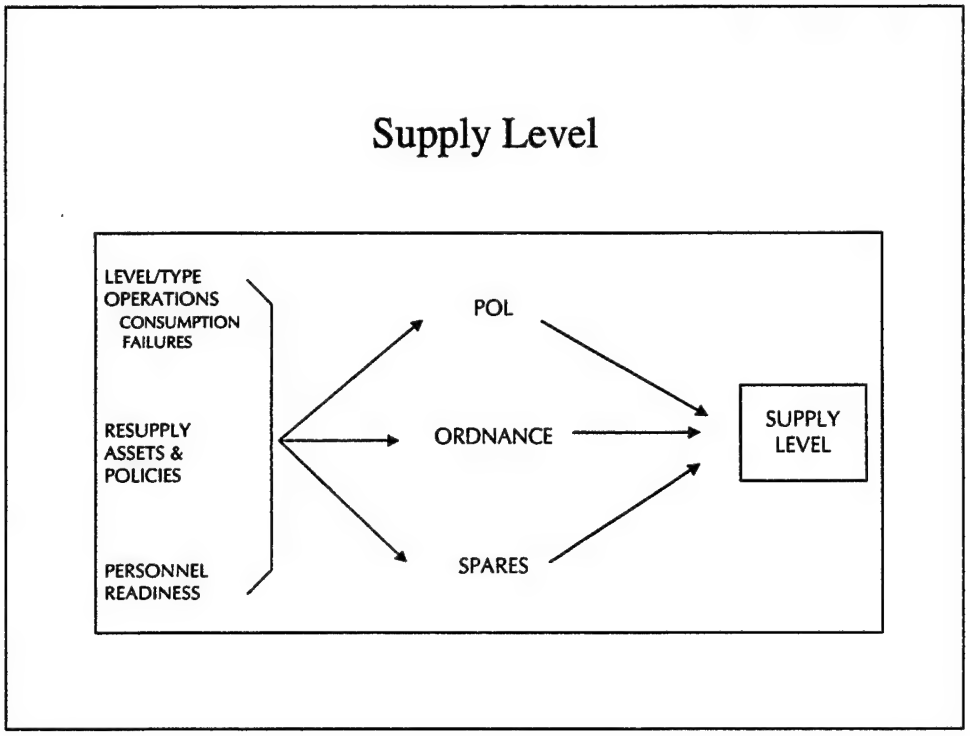


Personnel readiness is *characterized* by the quality and quantity of people assigned to a unit in the systems view.

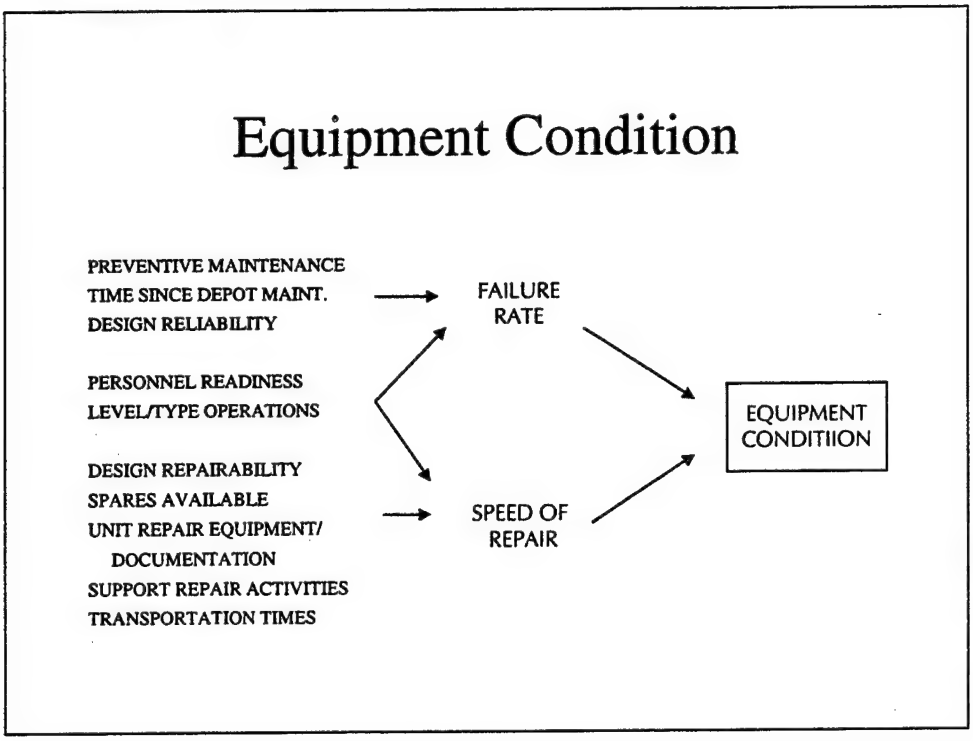
Personnel quality refers to the performance potential of individuals. Although performance potential is unobservable, a number of factors will influence the level of performance that can be expected. These include:

- The quality of recruits
- Training
- Experience
- Leadership

These attributes are influenced, in turn, by the programs and policies that support personnel. SimNavy would let the player influence spending on these programs.



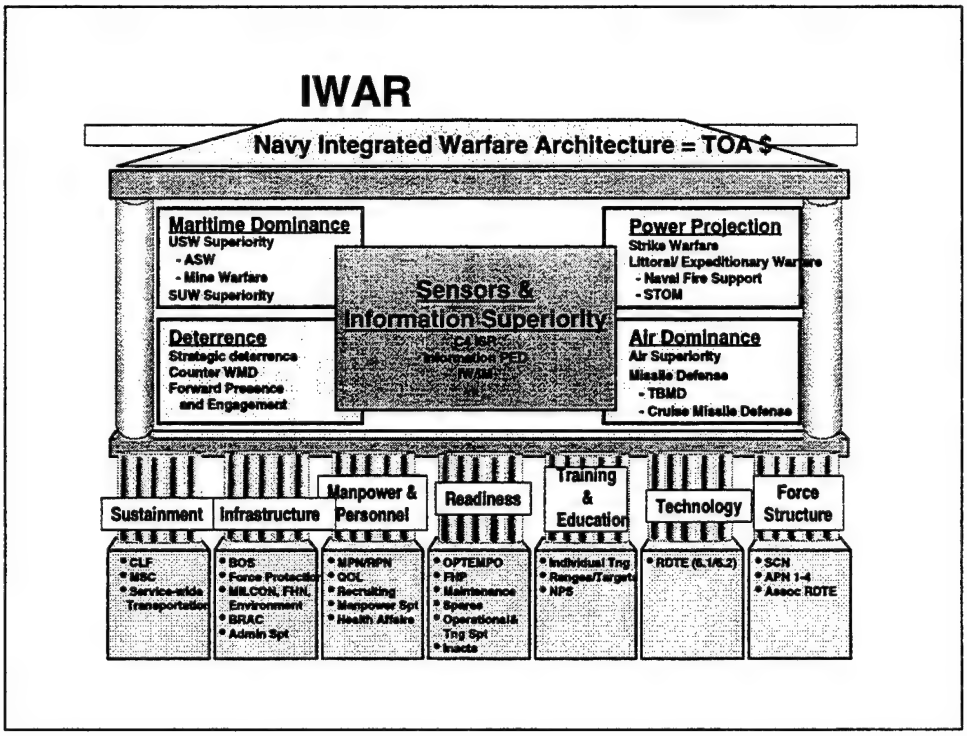
This is the systems view of factors that influence the level of supplies available to operational units. In addition to operations and resupply assets & policies, the quality and quantity of people who manage stores will play a role in having supplies in place when needed.



This is the systems view of factors that influence the operational availability of equipment. Personnel quality and quantity can affect the speed of repair as well as the failure rate, if maintenance is done incorrectly. Level and type of operations, spares availability, and other factors will also play a role.

Although the full systems view model is complex, some relationships have been empirically quantified with success. Using data archived by CNA researchers over many years, Junor and Oi [3] estimated the resource-to-readiness relationships portrayed above in order to predict the effect of changes in personnel quality on other parts of the readiness system.

These relationships will be useful if SimNavy is developed further.



Complex interrelationships within the full Navy enterprise are currently being modeled to support better resource allocation decisions. The Integrated Warfare Architectures (IWARS) are both broader and more detailed than the systems view. In its completed form, it is the complex behavior of this full Navy enterprise that SimNavy hopes to capture through agent-based technology.

Some Applications of Agent-Based Technology

- SimCity
- Project Challenge
- SimRefinery
- ISAAC
- ALBERT

Experiments using agent-based adaptive simulation are numerous and cut across a wide array of fields, including biology and ecology, economics and the social sciences, and combat. In addition, the technique has been used to create popular games and learning tools for the business community.

SimCity allows the "city planner" to build a city and grapple with the evolving consequences of his or her choices. Millions of copies of this game have been sold. SimCity was designed by Maxis Corporation. Thinking Tools, Inc, broke off from this group to focus on business-oriented learning tools [4].

Thinking Tools has produced a variety of games for educational purposes. SimRefinery, for instance, is used by a major oil company to familiarize its young MBAs with the workings of a refinery. Project Challenge teaches players how to manage a large project. A common element of these games is the ability to capture the imaginations of players who quickly learn through play.

Using internal research funds, CNA developed ISAAC, a semiautonomous agent-based adaptive simulation of ground combat [5]. The Marine Corps was so encouraged by the insights obtainable from this approach that it now sponsors a large project (ALBERT) that applies the technology to a variety of systems within the USMC, with the ultimate goal of improving combat effectiveness.

Unlike traditional top-down models that attempt to estimate average relationships for a few key variables, agent-based adaptive simulation is designed from the bottom-up to reveal how the overall system works.

The Technology in Game Format

- Engrossing play
- Effective experiential learning
  - Develop an understanding of a highly complex system without firsthand experience with each of its parts

Agent-based adaptive simulation appears to be a powerful tool for modeling highly complex interactive (i.e., adaptive) systems—systems that are too difficult to solve through mathematical solution.

In game format, essential lessons from these highly complex systems can be grasped quickly, through simulated experience. The resulting knowledge base should serve Navy officers, who will hold a variety of staff jobs over their careers, and handle a multitude of problems very well.

Role for CNA: Model Development and Quality Control

- Identify key agents
- Examine/provide rules of agent behavior
  - Conceptual linkages
  - Empirical evidence
  - Agent-based adaptive systems
- Test and Evaluation

CNA has both broad-based and in-depth corporate knowledge of Navy systems. Moreover, CNA analysts continue to expand their understanding of agent-based systems through support for research from ONR. Taken together, CNA has the ability to make important contributions to game design, development, testing and evaluation.

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